Greenbank Electronics

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PSUA-4 +25V, +12V, +5V, -12V POWER SUPPLY
'KEMITRON' BOARD.

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CONTENTS.

+25V, +12V, +5V, -12V Power Supply Board PSU-A-4

1.0 Introduction

This board provides various power supplies to suit the needs of the majority of small computer systems. It is not expected that every system will use all of the voltages available, and what may be termed the 'standard' arrangement will provide just +5V at 2 Amps, and + and -12V at about ½A.

2.0 Function

2.1 The board is slightly narrower (104mm) and longer (223mm) than usual (114x203mm), so that it can be bolted onto the side of a commercial 4" chassis module (e.g. RS type 509-349) which will then slide into the same rack as the other memory, processor, interface etc., boards in the system. A standard single-sided 0.1" edge connector can be bolted into the rack in the same way as for the other boards, and this will enable the whole power supply module to be withdrawn as a complete unit without having to disconnect any of the system wiring.

2.2 The 5V regulator cannot be fitted to the board as it requires a large heatsink (depending on the required power of course). Due to size or other reasons such other components as the large transformer, 10000μF reservoir capacitor, high power bridge rectifier etc., cannot be accommodated on the circuit board, and the 4" chassis module makes a very convenient mounting for these.

2.3 (It is perfectly permissable for the user to provide alternative mounting arrangements to the 4" chassis module specified, but for convenience the remainder of these notes will assume that the module is being used).

3.0 Circuit Description

3.1 3 - terminal integrated circuit voltage regulators are used throughout because they are (relatively) cheap, simple and easy to use. Nowadays they mostly all provide short circuit protection, and thermal limiting, to prevent damage to themselves and other circuitry. (There are ways to damage them however - see appendix 3).

3.2 The circuit diagram has been drawn assuming that all the regulators, fuses etc., are present. Individual constructors may have their own individual preferences, and of course are at liberty to change the design to suit themselves - e.g. five fuses may be thought to be an unnecessary extravagance, in which case they are easily deleted.

3.3 T2 is a specially wound 50VA transformer, and T1 is a small p.c.b. mounting commercial 3VA transformer (e.g. RS type 207-835), which is used to add a +25V d.c. supply if needed, for special system requirements (e.g. programming 2516's).

3.4 Referring to the circuit diagram, S1 is a double pole heavy duty switch and F1 is the main protection fuse. S2 is optional and is used to isolate T1 if (for example) EPROM-programming is not in progress; (if the +25V D.C. supply is permanently connected it is possible (depending on the actual circuit in use) for a runaway program to apply the +25V DC to an EPROM and destroy it). F2 is an optional fuse which is used to give extra overload protection to T1. (F1 necessarily has to be quite large and might not blow even if T1 was overloaded, due to the very small current T1 draws).

3.5 The two secondaries of T1 are connected in series to give 24V a.c., which is rectified by diodes D1-D4. No series resistor is required to limit the surge which occurs at switch on, as the IN4002 surge rating is 30A, and the 'inrush' current is limited by the transformer construction to much less than this figure.

3.6 C5 is the reservoir capacitor, IC4 the voltage regulator, and C4 is a low impedance tantalum capacitor. As +24V is the nearest standard voltage to +25V a resistor R1 is added to provide a 1 volt 'pedestal' at pin 2 of IC4, so that the output equals 24+1=25V. R1 may have to be selected on test, (for further details, and the reason why tantalum capacitors are used see Appendix 3).

3.7 The arrangements for the +5V,+12V and -12V regulators (IC5,IC2,IC1), which are suppled from the appropriate secondaries of T2, are broadly similar to that for IC4 already discussed. Fuses F3,4,5 are optional and have been included to protect against damage should any of the rectifiers fail. (As the reservoir capacitors C6,7,10 are quite large a failed rectifier diode would cause a grossly increased ripple current in the reservoir capacitors leading to excessive temperature rise and conceivably a literal explosion of the capacitor, which certainly could be messy and could be very dangerous).

3.8 There is less risk to C5 due to the much smaller capacitance and current.

3.9 There is no need for input current surge limiting resistors, for the same reasons as given in section 3.5. (The maximum surge permitted for D9 is over 200 Amps and the circuit impedance limits the actual surge current to less than this figure).

3.10 As indicated in Appendix 2, the actual dissipation in the rectifiers can be more than a casual calculation would indicate so it is suggested that D9 be mounted on a suitable piece of metal acting as a heat sink, by means of its integral mounting flange.

3.11 Except for IC4, already discussed, all the regulator voltages required are standard and so the 'COMMON' connections of IC1,2,3,5 are all made to 0V.

3.12 As IC5 has to be mounted on its own substantial heat sink, the wires to pins 1 and 3 can be quite long (i.e. more than a few inches). It may then be necessary to add C11 and C12 close to the pins of IC5 to improve transient response and prevent oscillations. Extra decoupling on the board is provided by C8,C9.

3.13 IC3 is a -5V regulator, which is fed from the same source (C7) as IC1, the -12V regulator. R2 has been included so that the current drawn at -5V causes a volt drop in R2, reducing the voltage presented to the IC3 pin 2, and so reducing dissipation in this component. The reason that R2 is required for this one regulator and not the others is due to the fact that the -5V is taken from a supply which has to be high enough also to feed a -12V regulator, and therefore there is an extra 12-5=7volts to be dropped.

3.14 If there was only a small current required from the -5V line, e.g. 30mA for a single 'bootstrap' 2708 in a mainly +5V system, then R2 could be replaced by a wire link, as the dissipation in IC3 would then be less than half a watt, which can easily be handled by a 7905 regulator with a heatsink.

3.15 Very often, in mainly +5V systems, the -12V supply is only used to provide the 10mA or so which is drawn by an ASCII Keyboard encoder (e.g. AY-5-2376). In such a case the 50mW or so dissipation which results can easily be handled by IC1 without its heatsink, or it could even be replaced by a 79L05.

3.16 Obviously the computer system itself will dictate how many different voltages will be required and what power will be drawn from each.

3.17 As a guide, our own personal suggestion is that -5V be omitted by leaving out R2, IC3, C3, HS3. Only three voltages in addition to earth (0V) should be fed down the bus: +12V, +5V, -12V. On those boards which require it the -5V should be developed using an onboard -5V regulator, or series 6.8V Zener Diode. This prevents the chance of a disaster if a board needing -5V is inadvertently plugged into a slot which is supplying -12V.

3.18 As the +25V line could wreak havoc if it got loose it is suggested that it not be sent down the bus at all, but instead be connected via front panel connectors, directly to the board which requires it, (In the same manner as 'patches' are made in some music synthesisers).

3.19 LED D10 can be mounted on the front panel to indicate when power is on. It can be taken from any rail but +12V has been chosen partly to balance the extra current which may be taken by the -5V regulator from the negative supply.

3.20 If an LED is connected to each supply it can make a most attractive front panel, as well as providing an instant diagnosis if the system is failing due to one of its supplies being absent. A further beneficial feature of this technique is that the LED current forces the regulator to regulate. (In the absence of any current loading on e.g. the +25Vd.c. line C4 could charge to a voltage considerably in excess of +25V, which would be disastrous if this was suddenly applied to an EPROM as part of the programming procedure).

3.21 If D10 is connected to a negative supply it must have its polarity reversed; R3 should be changed for other voltages (+5, -5V : R3=330), (+25V : R3 = 2k2).

3.22 It may be thought more convenient to mount one or more of the LED(s) on one or other of the cards in the system, this is clearly purely a matter of personal preference.

3.23 Numerous variations are possible without the need to modify the card extensively. It is possible to fit any of the positive or negative pin compatible voltage regulators e.g. for +12V,78L12 = 100mA, 78M12 = 500mA, 7812 = 1A.

3.24 IC4 is particularly versatile for special supplies e.g. if D1,2,3,4, and C4,5 are reversed in polarity a 7924 regulator can be used for IC4 to give a -25V supply. As a further example

T1 could be replaced by a (0,20V) + (0,20V) type and R1 by a 24V 27V Zener Diode (cathode to earth, for a negative supply) to give a -50V supply, which is the voltage needed to program early EPROMS. (The voltage rating of C4 and C5 would in this case need to be increased as well as reversing their polarity).

3.25 As it is envisaged that IC4 will not need to dissipate much power it can be mounted vertically to the p.c.b. with no heatsink, but even in this position a heatsink can still be bolted on if special conditions dictate.

4.0 <u>Construction</u>

4.1 Construction is fairly straight-forward, but should be carried out with a great deal of care e.g. the leads of IC1,2,3,4 should be bent with a pair of pliers on the component side of the bend so as to relieve any stress on the package seal. The need for care will be appreciated when it is remembered that the loss of the 'common' connection or a poor joint to the regulator i.c.s will result in raw unregulated d.c.being fed direct to the rest of the computer. This sort of error could easily destroy hundreds of pounds worth of components in the computer itself.

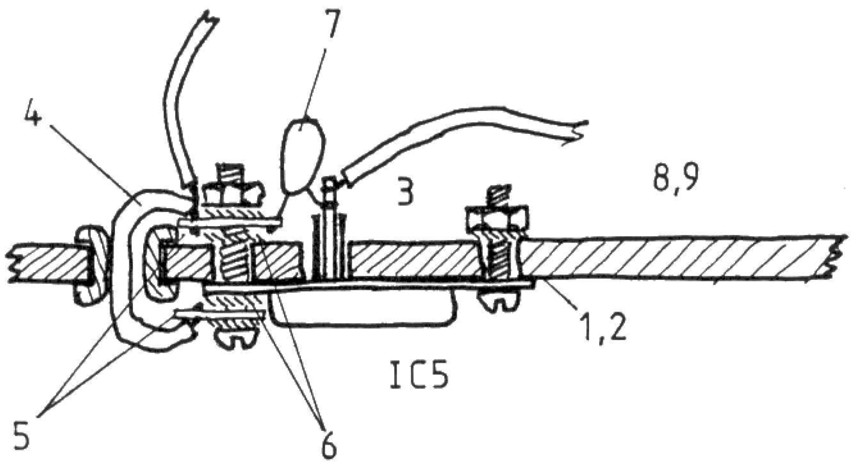
4.2 This possibility does mean that a ready-made crowbar protected 'switchmode' power supply could easily pay for itself if it prevented just one disaster of this kind.

4.3 IC5 can be mounted on the baseplate supplied with the module (see exploded view) or on your own flat sheet of aluminium, bolted to the side. If this is done cooler operation will result and ventilation can be improved by mounting C10, D9, and fuses etc., on the side panel and discarding the bottom panel.

4.4 Certain makes of finned heat sink extrusions can be mounted without too much difficulty and these would be even better for IC5.

4.5 Note that the mounting tabs of IC1,3,4 are not at earth potential and should be kept clear of bare earth wires etc. They could be insulated using mica washers and an insulating kit or plastic nut and bolt but it is doubtful whether or not it is worth the trouble.

4.6 Good workmanship is needed around the area of IC5 due to the higher currents involved. The following sketch shows the main points.



1. Mounting surface should be smooth and burr free.
2. Use heat sink compound for good thermal conduction.
3. Sleeve the IC5 pins to prevent shorting to the case.
4. Use wire through a grommet to make the case connection (it is considered bad practice to use a fixing bolt as a conductor, but we would not insist on this point ourselves, if say a brass bolt was used).
5. Use solder tags for all wire connections.
6. Use serrated lock washer to break through surface film of oxide on the solder tag and the aluminuim surface, also serrated washer in normal position under nuts.
7. C11 an C12 (if fitted) should be mounted neatly, close to the regulator pins, and to a solder tag to earth.
8. Do not use excessive force when tightening nuts.
9. Do not bend regulator pins or put them under any strain (this can damage the internal seal and/or connections and lead to premature failure - immediately, or days months or years later).

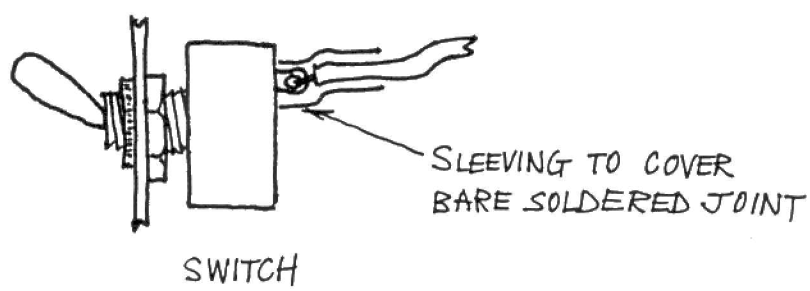
4.7 Be especially certain not to confuse the input and output pins of the regulators especially IC5 - this is one of the few circumstances which the regulator cannot protect itself against.

4.8 Panel mounting fuse holders are suggested for the mains supply as they are easier to insulate. Chassis mounting or panel mounting fuse holders can be used for the remainder. The panel mounting

fuseholders can be mounted on the front or rear panels or even on the side panel if there is one, and if the resulting projection would not make the module too wide to suit its proposed space.

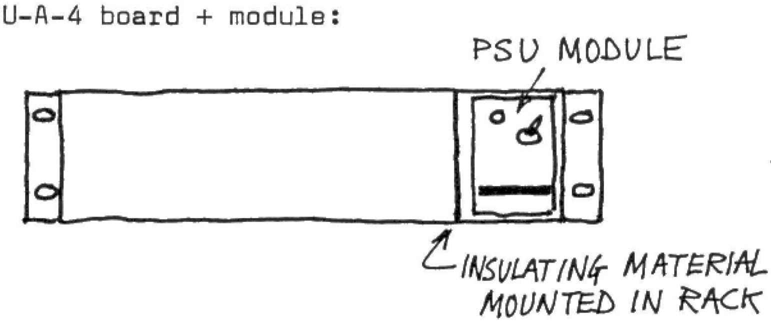
4.9 When soldering wires to a panel mounted LED, e.g. D10 be particularly careful as LED's and their case are very vulnerable to excess heat. The series resistor R3 (suitably insulated) can be bundled in with the wires to the D10, but if several LEDs are being fitted, with their series resistors it might be neater to make a little board wing 'Veroboard' or similar to mount the LEDs and resistors.

4.10 For safety's sake all mains connections should be sleeved:



4.11 Any remaining hazardous voltages should be suitably enclosed or otherwise insulated to prevent electric shock.

4.12 The area of the circuit board which has 'live' tracks should be insulated e.g. with a sheet of perspex bolted over it; another method, which would not obstruct ventilation, would be to insert a sheet of insulating material into the rack, a short distance from the PSU-A-4 board + module:



5.0 Testing

5.1 The only component that may need some alteration on test is R1. If the +25V.D.C supply voltage is too low R1 must be increased, if it is too high it should be decreased. (Remember to provide a load of

about 1k if there is no other load on the supply - this applies to all of the regulators). A reasonable tolerance on the +25V supply would be plus or minus 0.5V, so it is not necessary to select R1 exactly. Be especially careful to solder R1 well as a dry joint here would leave the +25V supply unregulated.

5.2 It is necessary to discharge the reservoir capacitors before doing any work on the supply after it has been on ; use a low value resistor, (e.g. 100R) not a screwdriver or piece of wire!

5.3 The blue flash which results is very pretty but it causes a huge current which the capacitors are not designed to withstand.

5.4 If an oscilloscope is available it should be used to examine each of the output voltage rails when maximum and minimum currents are being drawn. Ensure that there are no oscillations and that the ripple voltage on the input to each regulator does not fall so low in the troughs as to cause the output voltage to be affected. A very rough check can be made on the rectifiers by examining the frequency of the ripple voltage on the reservoir capacitors C5,6,7,10 - it should be a 100Hz sawtooth

A1.0 Appendix 1 Transformer calculations

A1.1 It is a common fallacy to assume that the a.c. r.m.s. output current rating of a transfomer is the same as the rectified d.c. which may be drawn. Depending on the circuit configuration it is always necessary to derate it, and in the case of the bridge rectifier circuits used here the derating factor is 0.6. (Common-sense shows that this must be so e.g a 24V a.c. 0.125A a.c. r.m.s. transformer after rectification will have a d.c. voltage approaching 32 volts - it would be to good to be true if this increase in voltage was not accompanied by a decrease in current).

A1.2 Taking the transformers used here as an example, the d.c. currents available are as follows (using the relations I.d.c. = I.a.c. x 0.6) and V.d.c. = $(\sqrt{2} \times Vac) - 2$.

A1.3 Table 1

Transformer	A.C.Volts	A.C.Current	D.C.Volts	D.C.Current
T1	24	0.12A	32	70mA
T2	9	3.3A	10.7	2.0A
T2	12-0-12	0.7A	16-0-16	0.4A

A1.4 (These are fairly conservative ratings and so the currents may be increased, provided a close watch is kept on the temperature rise).

A2.0 Appendix 2 Ripple Current and Voltage.

A2.1 Most libraries can loan the relevant textbooks on this subject and the user is referred to these for the detailed theoretical treatment in this area of circuit design.

A2.2 However, there are a few points which are not fully appreciated and need stressing.

A2.3 The output of the integrated circuit regulators is virtually free of ripple provided the input ripple voltage does not cause the input to the regulator to fall below a given minimum voltage (see Appendix 3 for details), and may be calculated from the following formulae:

$$Q_1 = CV \qquad (1)$$
$$Q_2 = ixt \qquad (2)$$

where
Q_1 in Coulombs is the charge on a capacitor value C Farads charged to V volts (equation (1)), and Q_2 in Coulombs is the charge which results when a current i Amps flows for t seconds (equation (2)). If it is assumed that $Q_1 = Q_2$ and i = is constant, then using $t = 2\pi/W$ (where W radians / sec is the angular ripple frequency = 200π in this case), then the ripple voltage:

$$VR \text{ (pk-pk)} = i \times 2\pi / C \times 200$$
$$= i / 100 \times C \text{ volts}$$

A2.4 The following table gives the calculated values of ripple voltage for typical maximum loads.

A2.5 Table 2

Capacitor No	Value(µF)	Peak Volts	Current Amps	Ripple pk-pk
C5	470	32	0.07	1.5V
C6	2200	16	0.4	1.8V
C7	2200	16	0.4	1.8V
C10	10000	10.7	2.0	2.0V

A2.6 The most important rating, (which is also the most often over-looked) is the ripple current rating of the reservoir capacitor.

We have V_R(pk-pk)= $2\pi i/WC$ (From Section A2.3)

If the ripple voltage is taken as being sinusoidal (actually it isn't, but assuming a sinusoid eases calculations and gives a "worst case" answer), the ripple current in the reservoir capacitor can be calculated from the following formulae:

$I_c(pk\text{-}pk) = WCV_R = WC\left(\frac{2\pi i}{WC}\right)$, so $I_c(r.m.s.) = \frac{1}{2\sqrt{2}}(2\pi i)$ $\boxed{\text{i.e. } I_c(r.m.s) = 2{\cdot}22\,i}$

A2.7 For the example currents quoted in table 2 above the required minimum ripple current rating for the capacitors is as in the following table.

A2.8 Table 3.

Capacitor No	Value(uF)	Assumed d.c.current	Required a.c.ripple current
C5	470	0.07 A	0.16 A
C6,C7	2200	0.4 A	0.89 A
C10	10000	2.0 A	4.44 A

A2.9 Naturally the capacitors we supply have been chosen with a more than adequate ripple current rating, but if others are used they should be selected with care - C10 in particular needs to be a 'computer grade' component (i.e. high ripple current).

A2.10 If the ripple current rating of a capacitor is inadequate, this causes excess dissipation in the effective series resistance of the capacitor, with resultant overheating, pressure build up and conceivably violent explosion of the capacitor can itself.

A2.11 There is one ripple current excess that needs to be protected against - failure of one or more diodes D1 - D8 or of those in the ridge rectifier D9 can result in raw a.c. being fed directly to the affected reservoir capacitor, and greatly increased a.c. ripple current. The only protection device which can be used here is a fuse in the secondary e.g. F3, F4,F5 (there is no provision for a fuse for T1 but this is less vulnerable due to the smaller currents involved, and it is difficult to obtain fuses of a low enough rating. Of course a fuse could be incorporated here also if the user felt strongly enough about it, but it would involve breaking the copper track between T1 and the diodes).

A2.12 The possibility of failure of a diode is fairly remote due to the substantial diodes and bridge rectifier specified and many users may consider there is adequate provision in having fuses F1 and F2 in the primaries which will protect to some extent against faults in the secondary windings of T1 and T2.

A2.13 Due to the large inductive and capacitve current surges the fuses are best chosen as 'anti-surge' types as the rating of a 'quick-blow' type would have to be increased so much to cope with the surge that it would be of too high a rating to provide anything but protection against the most gross of faults. The current ratings should be as small as possible to suit your own particular system, consistent with avoiding 'nusiance' blowing when no fault is present.

A2.14 D9 is specified as a chassis mounting component because there is a significant amount of power dissipated, even though only it is being used at much less than its maximum rated current. There are two diodes at a time which conduct in a bridge rectifier and they only conduct when the a.c. input sinewave is near its maximum - perhaps for a $^1/5$ of each $\frac{1}{2}$ cycle. Thus for an average 2 Amps, a peak current of at least 10 Amps is necessary. Assuming a 3V drop in the two diodes at this current this means a peak dissipation of 3V x 10A = 30W or 30 x $\frac{1}{4}$ = $7\frac{1}{2}$W on average, which would cause a significant rise in temperature if a heat sink was not used.

A3.0 Appendix 3 Regulator Protection

A3.1 The integrated circuit regulators are fairly straight forward to use particularly if the circuit requires a 'standard' voltage. Most modern types are protected internally against excessive current and excessive temperature - this leads people to think that they are virtually indestructible which is sadly not the case. The following list mentions some of the ways in which i.c. regulators can be damaged and the user is earnestly requested to read through this list (unless he is willing to pay for his own replacements of course!).

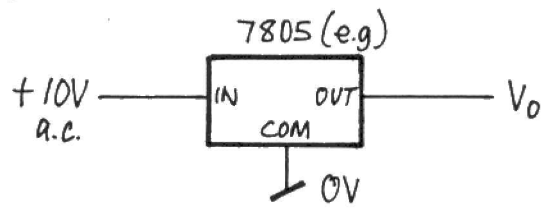
A3.2 Bending leads near the seal. Chassis mounted regulators should not have the leads bent unless absolutely necessary, and ones mounted on the p.c.b. should have a large radius bend well away from the regulator body, holding pliers on the regulator side of the bend to avoid any strain. Damage from this cause may not show itself until much later and can be due to thermal cycling of internal bonds and or humidity corrosion.

A3.3 Inadequate heat sink: Although the devices are generally internally protected against this, operation for prolonged periods will certainly shorten the expected time before failure. One manufacturer stresses that operation in the thermal shutdown mode is not recommended.

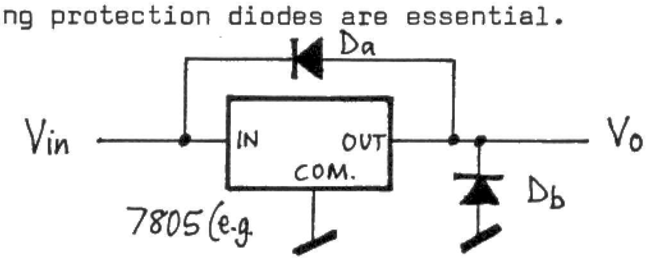
A3.4 Excessive Input Voltages

The maximum permitted input voltage is in the order of 15 volts more than the specified output voltage. Care is required if a given output is lightly loaded and if the mains input to the transformer is at the high end of its tolerance. Forexample a 10% increase in mains voltage would increase a 240v.a.c. input to 264 volts, and a typical regulation of 21% for a 3VA transformer would result in a increase of 31% on a lightly loaded secondary. This would mean that a nominal rectified output of 24V $\times \sqrt{2}$ = 34V could rise by as much as 10V. Once some current isdrawn the transformer voltage will drop and there will be some drop in the rectifier diodes, but it is clear that 'no load' conditions late at night (when mains voltages are 'up') needs to be considered with care.

A3.5 Negative and 'back' Voltages The voltage regulators are only safe when the output voltages are of the same polarity, and smaller than the input voltage e.g. in the following circuit



Vo must be less than +10V and never negative. If there is any danger that these conditions might not be met the following protection diodes are essential.



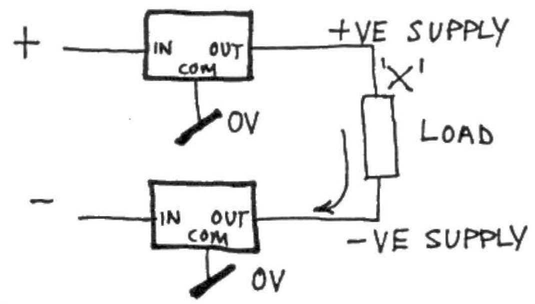
Da prevents Vout rising substantially above Vin, and D_b prevents Vout becoming negative.

A3.6 It might be thought an unlikely possiblility that conditions causing damage can occur, but ways it can happen are as follows. If Vout has a lot of capacitance on its line (almost always the case in a computer where electrolytic capacitors are to be found on every board) and Vin is

suddenly reduced Vout can stay high when Vin is low and and a reversed (and damaging) current, can flow. This problem and the similar one of Vout changing polarity, occurs when one transformer and bridge rectifier is feeding positive and negative supplies, and it is most acute at "switch on" and "switch off"; various supplies may just for an instant rise at different rates, and some i.c.s etc., can conduct between different rails and cause temporary freak current flows which disturb the voltages in a damaging way.

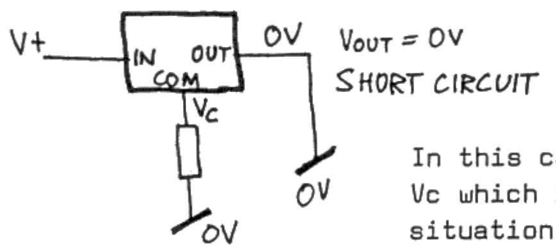
A3.7 It is true that the loss of a supply, or incorrect voltage will persist only for an instant, but this is more than sufficient time for damage to be done to the supply or system using a single on-off switch is not a complete solution, due to the different rates the various supplies rise, but in most cases no special precautions seem necessary. (This observation is only based on experience as it cannot theoreticaly be supported).

A3.8 Another way a voltage can 'cross-over' is in the following circuit:



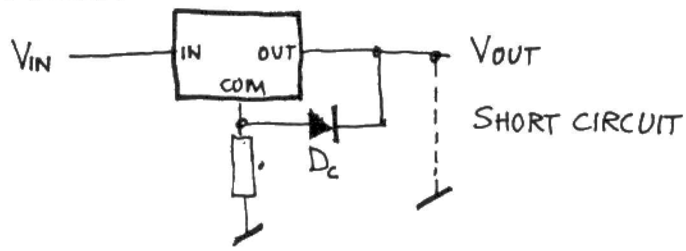
A3.9 If say the +ve supply goes into current limits due say to more load or a fault on the +ve line the -ve supply will 'pull down' below OV the point marked 'X', reverse biasing, and probably destroying, the +ve regulator. Again, protection diodes are the answer if this sort of condition can occur.

A3.10 A resistor, diode, zener diode, transistor etc., can be inserted in the 'common' terminal line to provide an increased voltage see next section for details. The circuit is as follows and is shown with a short circuited output.



In this case Vout can be below Vc which is a potentially damaging situation.

A3.11 Protection against this can be by yet another diode Dc in the circuit below:



A3.12 To cause damage the 'output' terminal has to be well below that of the common terminal and so in the PSU-A-4 circuit IC4 does not need this protection.

A3.13 The method used for calculating the resistor is to use the formula R=V/Iq where V is the required voltage drop and Iq is the current which leaves the regulator via the 'common' terminal e.g. In the PSU-A-4 circuit the regulator has a +24V output, and +25V is required, so the voltage needed at the common terminal is 1V. Iq for the 7824 regulator is typically 4.7mA so R= 1/4.7 = 220 ohms. On the circuit diagram it is shown as a 'select on test' component because the output voltage of the 7824 can already vary between 23V to 25V according to its specification, and Iq can vary be several milliamps from sample to sample and also with temperature.

A3.14 (Remember when testing to provide a load of several milliamps at least, and never leave R1 open circuited).

A3.15 It has already been mentioned (Section 3.20) that the output voltage of these regulators can rise when they are not loaded so a load must always be provided if this would cause damage (e.g. the +25V line and 2516 EPROMs) or when measuring the output voltage.

A3.16 In addition to the large electrolytic reservoir capacitors there are numerous other capacitors which are often recommended by the i.c. regulators to improve transient response and prevent oscillations. The values chosen will suit the requirements of all the commonly available regulators and can often be reduced or eliminated depending on the actual conditions of use, wiring layout etc.

A3.17 Tantalum bead capacitors have been used where the cheaper ordinary electrolytic types would be inadequate due to their poor high frequency response.

(The common expedient of using an electrolytic capacitor in parallel with a high frequency ceramic is not always successful because there will be a frequency where the ceramic capacitor will resonate with the series inductance of the electrolytic capacitor which can make matters worse not better!)

A4.0 Appendix 4

A4.1 System Considerations

A4.2 As the 3 terminal regulators are regulating with respect to their common terminal (which usually is ultimately connected to earth) it must be certain that all high current earth return paths are made using thick copper wire and preferably return to one central earth point. As explained in section A2.14 very large pulse currents can flow in the rectifiers and reservoir capacitors. If the common connection of an i.c. regulator was taken via a heavy current path instead of to earth, this could result in the resultant volt drops being impressed on the regulated output voltages. Depending on the earthing arrangements of an oscilloscope probe these would not necessarily show up visibly but they could cause damage or malfunction in voltage sensitive memories etc., elsewhere in the computer, which would otherwise be very difficult to locate.

A4.3 Wiring to the power bus of the computer and the power bus itself whould be of an adequate gauge to prevent any unacceptable volt drop along its length.

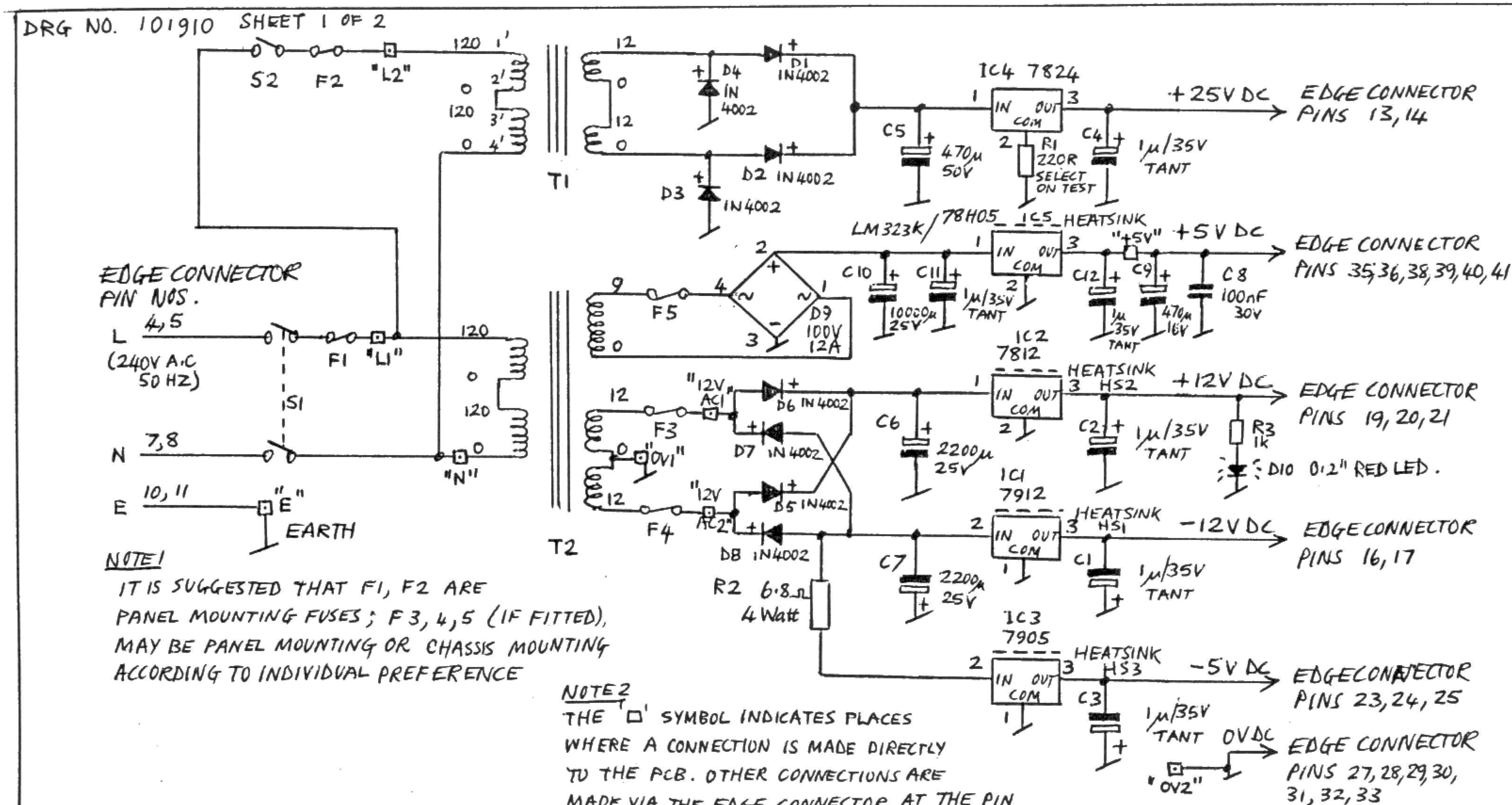
A4.4 At all times all voltages should be provided to all the places they are used. With multirail i.c.s the loss of one supply can often result in the destruction of the whole chip. Most people disregard this problem, and find a single on/off switch for the mains power is adequate but if there is a risk of damage, arrangement power supply sequencing should be made, and consideration given to making the loss of one vulnerable supply to automatically shut down the others (using e.g. 'crowbar' circuitry).

A4.5 Tantalum capacitors which are used extensively due to their superior properties are inferior in one respect - they are not able to withstand sudden surge currents either charging or discharging.

This is one of the reasons why a board must never be plugged into a 'live' computer system - the power bus will be at its full voltages backed up by fully charged substantial reservoir capacitors, whereas the board to be plugged in will have fully discharged capacitors and connecting the two will have the following detrimental effects. All capacitors affected will be subjected to unlimited surge currents grossly outside their ratings, and electrolytic and particularly tantalum bead capacitors can easily be damaged or reduced in efficiency by this treatment. The same current will flow through the regulators causing them to current limit, which is permissable only as an occasional protective mechanism not as a regular means of abuse, and as a result all or some voltage rails can suffer a drop. As explained previously the loss of one or other of the supply rails can be potentially very destructive.

A4.6 There are numerous occasions when the user will be tempted to plug in boards 'live', by accident or design, and everybody who has a computer system will have done so at one time or another. The difficulty is that damage can occur which will be so slight that it will go unnoticed at the time but may nevertheless result in an otherwise unexplained failure of components at some future time. It is a similar situation to a person being knocked down by a car. Once or twice it can happen without apparent ill effects but if a pedestrian makes a habit of being knocked down again and again eventually failure will result.

DRG NO. 101910 SHEET 1 OF 2



NOTE 1

IT IS SUGGESTED THAT F1, F2 ARE PANEL MOUNTING FUSES; F3, 4, 5 (IF FITTED), MAY BE PANEL MOUNTING OR CHASSIS MOUNTING ACCORDING TO INDIVIDUAL PREFERENCE

NOTE 2

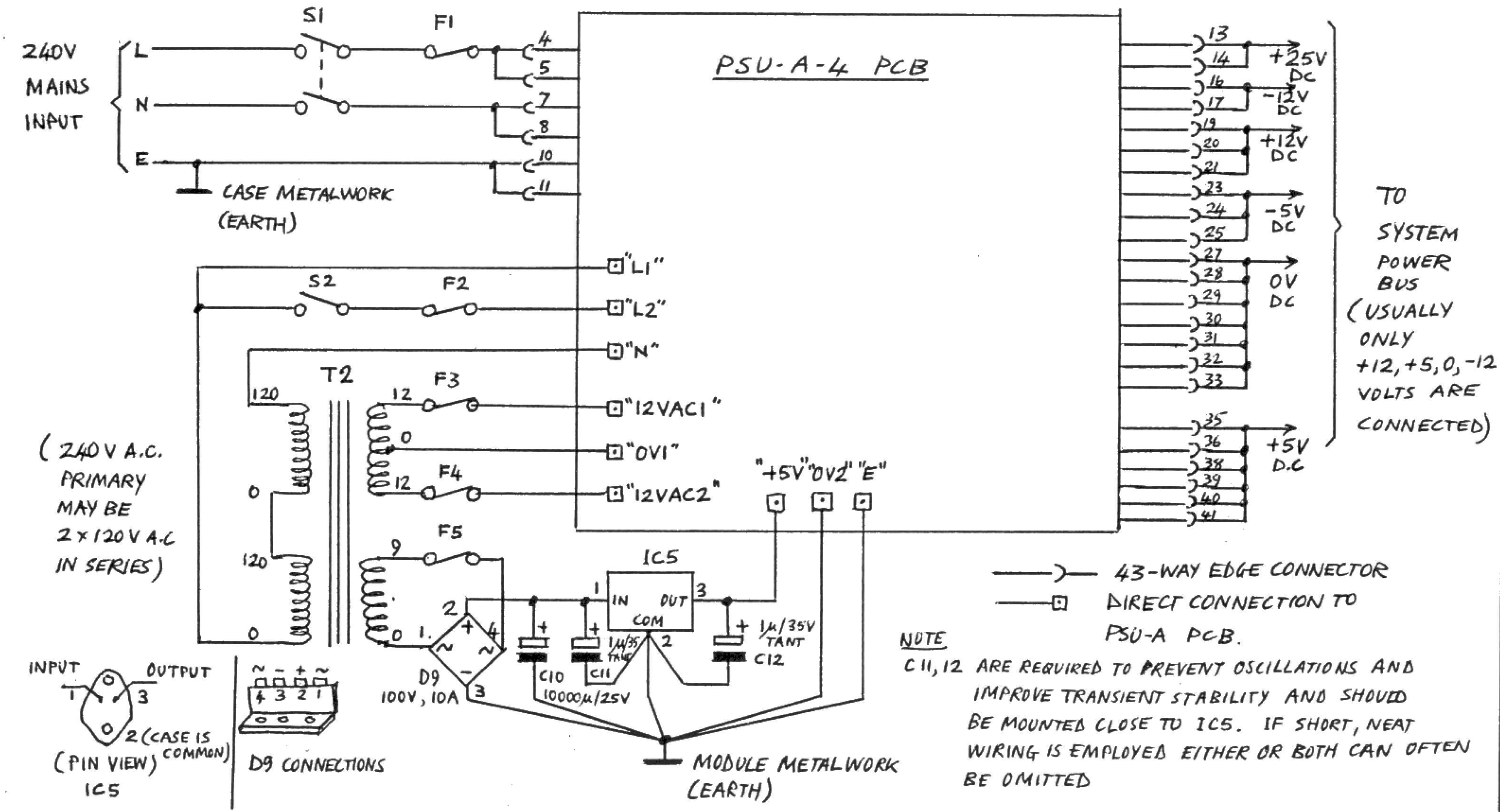
THE '□' SYMBOL INDICATES PLACES WHERE A CONNECTION IS MADE DIRECTLY TO THE PCB. OTHER CONNECTIONS ARE MADE VIA THE EDGE CONNECTOR AT THE PIN NUMBERS INDICATED.

CIRCUIT DIAGRAM OF PSU-A-4 PSU BOARD + MODULE

DRAWING NO 1.01910
SHEET 1 OF 2

DMP. 28-2-80

DRG. NO 101910 SHEET 2 OF 2

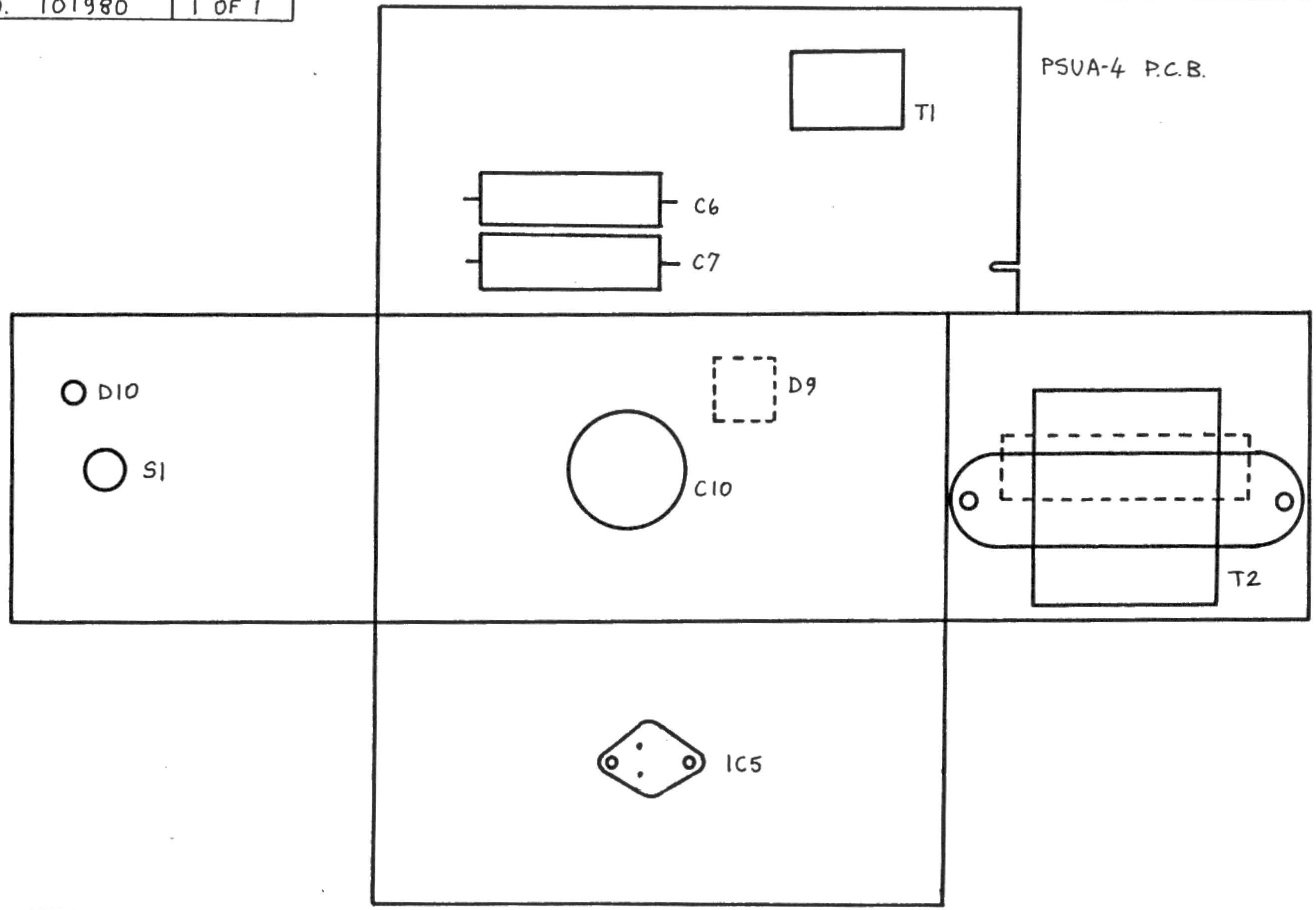


MODULE WIRING DIAGRAM FOR PSU-A-4 PSU BOARD

DRAWING NO. 101910 SHEET 2 OF 2

DMP 27-2-80

DRG NO. 101980 | 1 OF 1



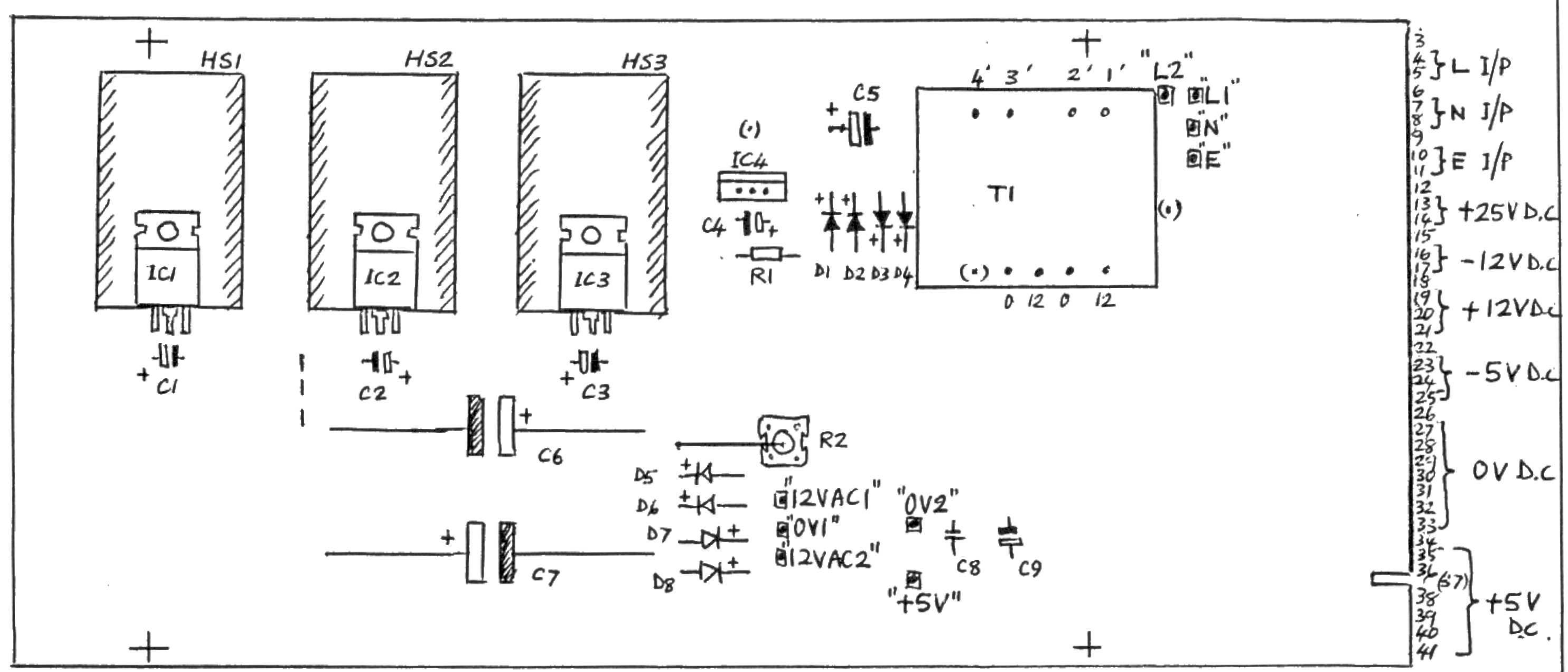
ENG.	J.S.D.	8-12-79
DRAWN	DMP.	2-8-80

GREENBANK ELECTRONICS

PSUA-4 MODULE EXPLODED VIEW

DRG. NO. 101980 | 1 OF 1

DRG. NO. 101930 SHEET 1 OF 1



COMPONENT LAYOUT FOR KEMITRON PSU-A4

DRAWING NO. 101930 SHEET 1 OF 1

DMP. 26-2-80

COMPONENTS LIST FOR PSU-A-4 'KEMITRON' BOARD TO FORM +5V, +12V, -12V SUPPLY

List Ref PSU-A/P2
(sheet 1 of 2) Feb 1980

DOCUMENT NO. 101940
SHEET 1 OF 2

Resistors

1k 1/8 W	1	R3

Capacitors

100nF cer.	1	C8
1µF/35V tant	4	C1-2, 11-12
100µ/16V elec	1	C5 ← 470µ/16V 1 C9
2200µ/25V "	2	C6-7
10000µ/25V "	1	C10

Diodes

IN 4002	4	D5-8
100V/12A Bridge	1	D9 (e.g. RS 261-198)
0·2" RED LED	1	D10

Integrated Circuit Regulators

7812	1	IC2
7912	1	IC1
LM323K/78H05	1	IC5

Transformer

9V, 12-0-12	1	T2 (special)

Sundries

Heat Sink 401-964	2	HS1-2 For IC1-2
Mounting clip for C10	1	
Mains sw DPST	1	S1
4" Chassis Module	1	509-349 undrilled

Options

20mm Fuseholder panel mtg.
" " chassis "
" Antisurge fuse

Extras, not normally supplied

Sheet aluminium to form heatsink for IC5
Terminal Pins, nuts, bolts, washers, wire etc.

ADDITIONAL COMPONENTS TO ADD +25V to PSU-A-4 Board

List Ref PSUA/P2 (sheet 2) Feb 1980

DOCUMENT No. 101940
SHEET 2 OF 2

Resistors		
220R (Select on test)	1	R1
Capacitors		
1µ/35V tant. R	1	C4
470µ/50V elec R	1	C5
Diodes		
IN 4002	4	D1-4
Integrated Circuit Regulator		
7824	1	IC4
Transformer		
2×12V, 3VA	1	T1 (e.g. RS 207-835)

ADDITIONAL COMPONENTS TO ADD -5V to PSU-A-4 Board

Resistors		
6·8 ohm 4W	1	R2
Capacitors		
1µ/35V tant R	1	C3
Integrated Circuit Regulator		
7905		
Sundries		
Heat sink 401-964	1	HS3 For IC3

Options
20 mm Fuseholder panel mtg
" " chassis "
" Antisurge fuse (0·4A-2A

Extras not normally supplied
Sheet Aluminium to form heatsink for IC5
Terminal pins, nuts, bolts, washers, wire etc.
Insulation material e.g. sheet 'Perspex' to insulate the mains voltage tracks if there is a danger of them being touched.